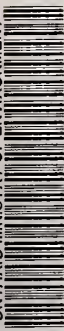


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ONTARIO MINISTRY OF ENVIRONMENT



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IMPACT OF THE OWEN SOUND SANITARY LANDFILL ON DOMESTIC WATER SUPPLIES, DERBY TOWNSHIP, GREY COUNTY

April, 1976

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Impact of the Owen Sound
sanitary landfill on domestic
water supplies, Derby
Township, Grey County /
82458

ONTARIO MINISTRY OF THE ENVIRONMENT
SOUTHWESTERN REGION
Technical Support Section

IMPACT OF THE OWEN SOUND
SANITARY LANDFILL ON DOMESTIC
WATER SUPPLIES, DERBY TOWNSHIP
GREY COUNTY

by

Blagoje Novakovic

April, 1976
LONDON

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SUMMARY

The Owen Sound sanitary landfill is located on a kame moraine which according to water well records in the area is comprised of clayey silty sand, gravel, silty sand, and gravel and sand with boulders. These glacial deposits are characterized by poor sorting, variable composition and correspondingly variable permeability. In general, kame moraine deposits are considered to be unsuitable for sanitary landfill sites because of locally high permeability and this site is no exception. The bedrock in the area consists of dolomite with minor shale layers of Guelph-Lockport Formation.

Groundwater quality monitoring in area wells (in response to the local residents' complaints) indicated that groundwater had undergone quality changes in the vicinity of the landfill. Two domestic wells (three families) located in the immediate vicinity of the landfill were adversely affected by the operation of the Owen Sound sanitary landfill. The reduction in sulphate, increase in hardness, alkalinity, chloride, sodium, iron, COD, and presence of phenols and tannins and lignins in these two wells are directly related to the introduction of the leachate into groundwater.

The presence of the Owen Sound sanitary landfill poses a potential pollution hazard to other neighbouring wells and groundwater in general. Therefore, measures should be taken to minimize further impact of the leachate on the local

groundwater system. A planted low permeability cover appropriately graded and drained will reduce infiltration and therefore generation of leachate. Drilling and subsequent pumping of several wells downgradient from the landfill will partially remove pollutants from groundwater and restrict further migration. Some mutually acceptable means of water supply restoration to the affected parties remains to be worked out.

Efforts should be made to find an environmentally acceptable sanitary landfill site and terminate the use of the existing one.

INTRODUCTION

Deterioration of water quality in domestic wells located in the immediate vicinity of the existing Owen Sound landfill first came to our attention early in October, 1975. At that time the area residents approached this Ministry's District Office in Owen Sound and complained that their water supplies were adversely affected by the operation of a nearby solid waste disposal site. Hence, the purpose of this study is to determine the extent and mechanism of groundwater pollution originating from the existing Owen Sound sanitary landfill operation.

The disposal operation at the Owen Sound sanitary landfill site commenced in January of 1971 under a certificate issued by the Ontario Department of Energy Resources Management, Waste Management Branch. The application stated that this landfill site would serve the City of Owen Sound and the Townships of Derby and Sydenham. Fill was to consist of 20 percent domestic waste, 30 percent commercial and 50 percent industrial wastes with the total daily disposal of 500 tons. Using these figures and assuming that disposal operations were carried out five days a week, it was calculated that 660,500 tons of solid wastes were disposed here since the operation commenced until March 1, 1976.

Information from water well records in the area which are on file with the Ontario Ministry of the Environment (OME) were utilized and provided the hydrogeological framework for

this study. Because groundwater quality monitoring is continuing, and additional hydrogeological and pertinent data are being collected a final report may be prepared.

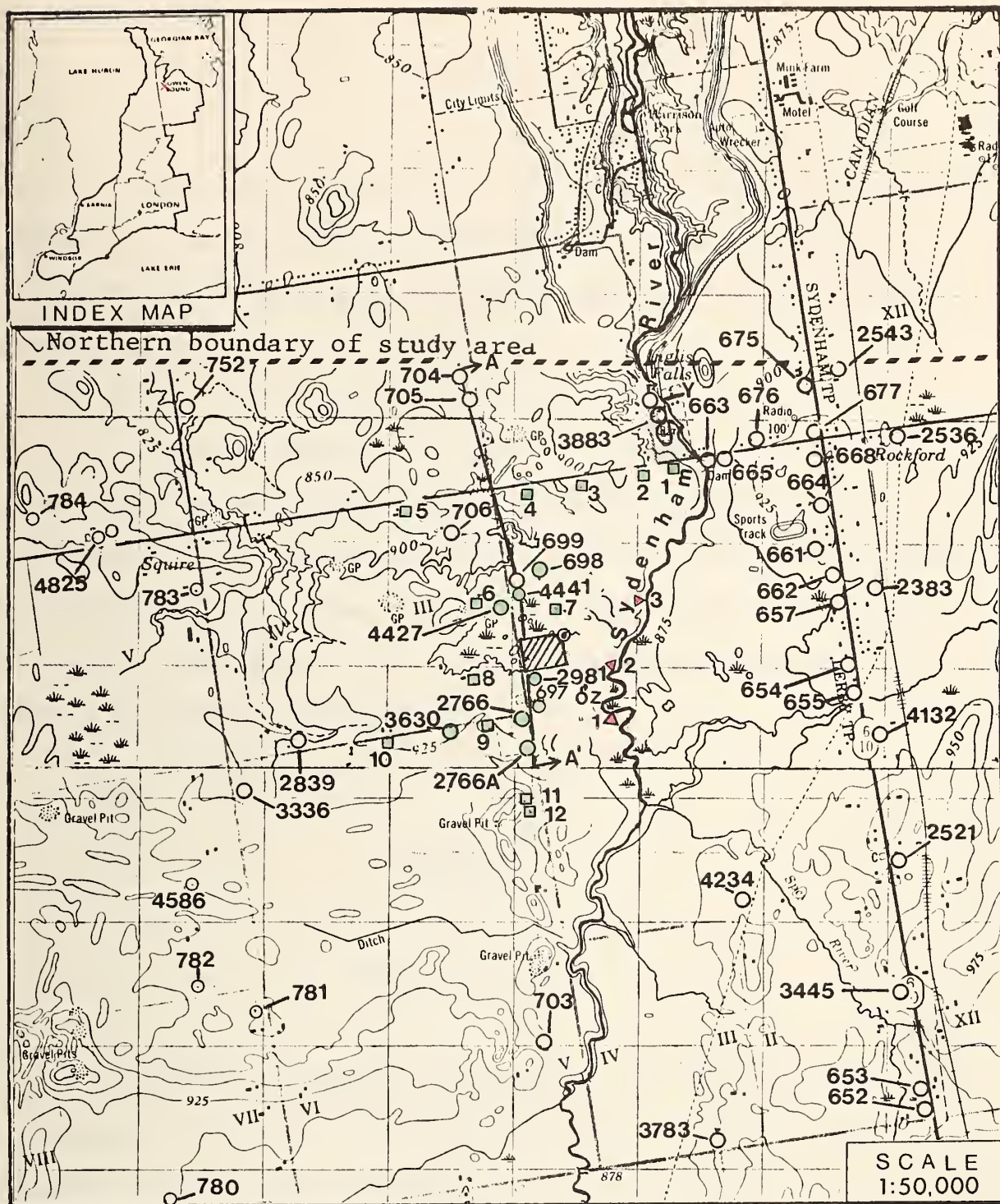
Location

The Owen Sound sanitary landfill site is located about three miles south of the City of Owen Sound. It occupies the northern part of Lot 7, Concession II, Derby Township, Grey County (Figure 1). The study area is located south of the east-west line passing through Inglis Falls as indicated in Figure 1.

Access to the site is provided by Concession Road 2 which is linked to Provincial Highway No. 10 by the Highway No. 6 bypass.

The area is characterized by hummocky topography and is part of a kame moraine oriented in a northeast-southwest direction. According to Chapman and Putnam (1966) this area is part of the Arran Drumlin Field physiographic region.

The existing landfill occupies part of a swampy area which extends west, north and east from it. The immediate area drains in an easterly direction into the Sydenham River which is about 1,400 feet away.



LEGEND

	Water well and OME well number; well record with OME		Well water sample location
	Water well and well number; no well record with OME		River water sample location
	Spring		Leachate spring
			Cross section location
			Landfill

FIGURE 1. LOCATION MAP.

Field Work

Field work consisted of groundwater quality monitoring in area wells which began in October 1975. This information was supplemented by analyses of available geological and hydrogeological data.

Figure 1 shows the location of water wells in the study area. Indicated well numbers are those as assigned by the Ontario Ministry of the Environment. The one and two digit well numbers shown in the same Figure are domestic wells for which there are no records on file, but from which chemical and bacteriological analyses are available.

GEOLOGY

Bedrock Geology

Bedrock outcrops occur about 9,000 feet northeast of the landfill site, but at the site bedrock is overlain by more than 100 feet surficial deposits.

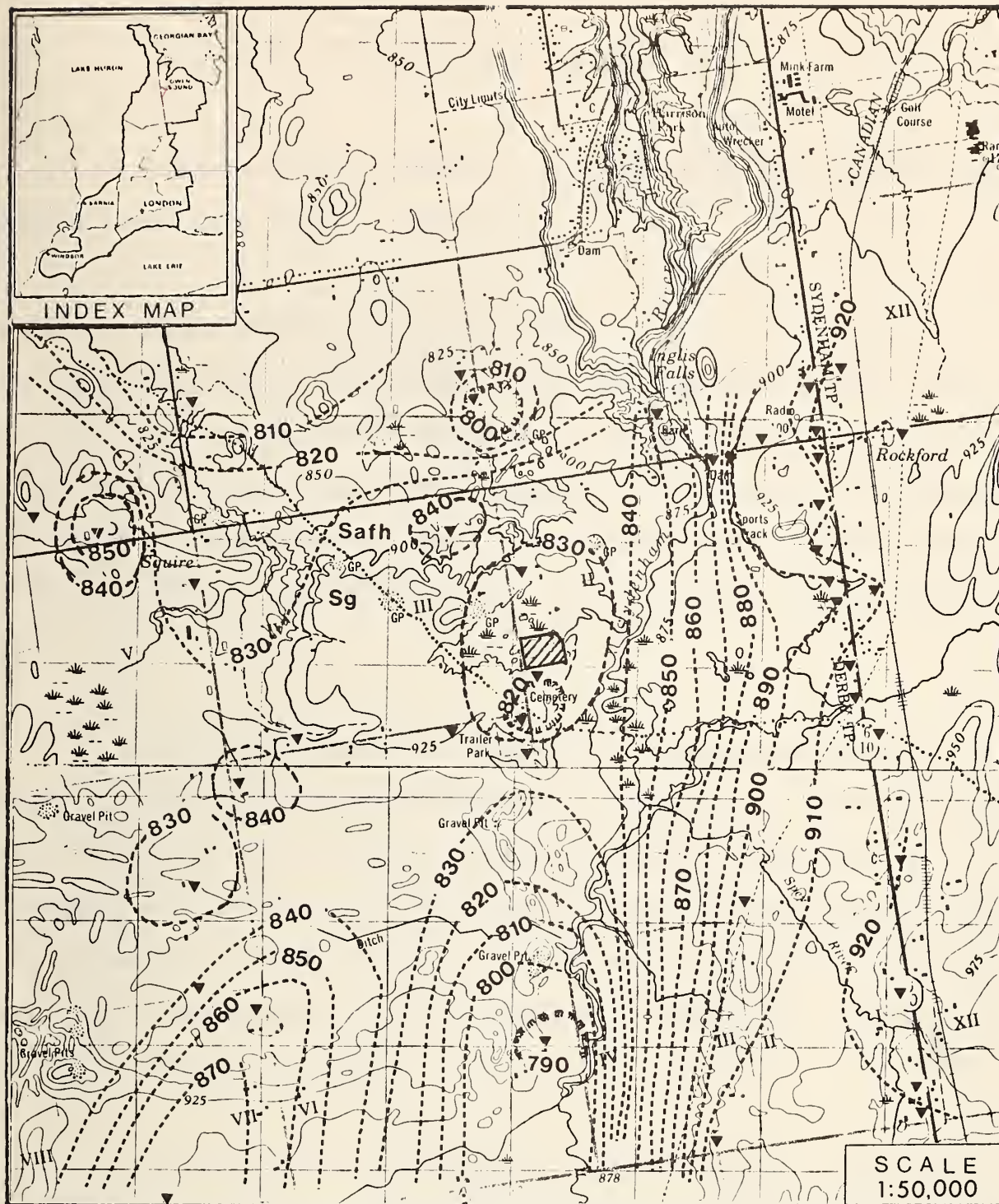
The bedrock formations within the study area are of Middle and Lower Silurian Age. They have been ascribed to the Amabel, Fossil Hill (Lockport) and Guelph Formations (Liberty, 1966). Both Lockport and Guelph Formations are lithologically quite similar consisting basically of massive dolomite.

A typical Lockport lithology is of grey weathering, bluish grey and blue mottled fine crystalline dolomite. Beds are massive and well jointed; biohermal strata are non-bedded and porous zones and vugs are present.

The Guelph Formation is largely a reefal complex. For the most part, this formation comprises tan to brown, evenly textured, fine to medium crystalline dolomite. Strata are weathered brown, massive and scraggy. Beds range from 4 to 24 inches in thickness (Logan, 1963) and vugs are known to occur.

Several water wells in the vicinity of the solid waste disposal site report shale layers within the massive grey dolomite.

The topography on the bedrock surface differs significantly from that of the present land surface (Figure 2) being somewhat more regular with uniform relief, but a significant bedrock channel occurs about one quarter of a mile west of Sydenham River (Figure 2). This bedrock channel trends in a north-south direction, but its exact location is uncertain because of lack of data. Most probably, its location coincides with the present course of the Sydenham River.



Bedrock geology: After B. A. Liberty, 1966.

LEGEND

PALEOZOIC


MIDDLE AND LOWER SILURIAN

Sg Guelph Formation: Brown crystalline dolomite

Safh Amabel and Fossil Hill forma-
tions (Lockport): Grey and blue
crystalline dolomite

▼ Control point

Bedrock surface contour a.s.l. in feet
(interval 10 feet)

 Geological boundary
(approximate)

☒ Landfill

FIGURE 2. BEDROCK GEOLOGY AND BEDROCK TOPOGRAPHY.

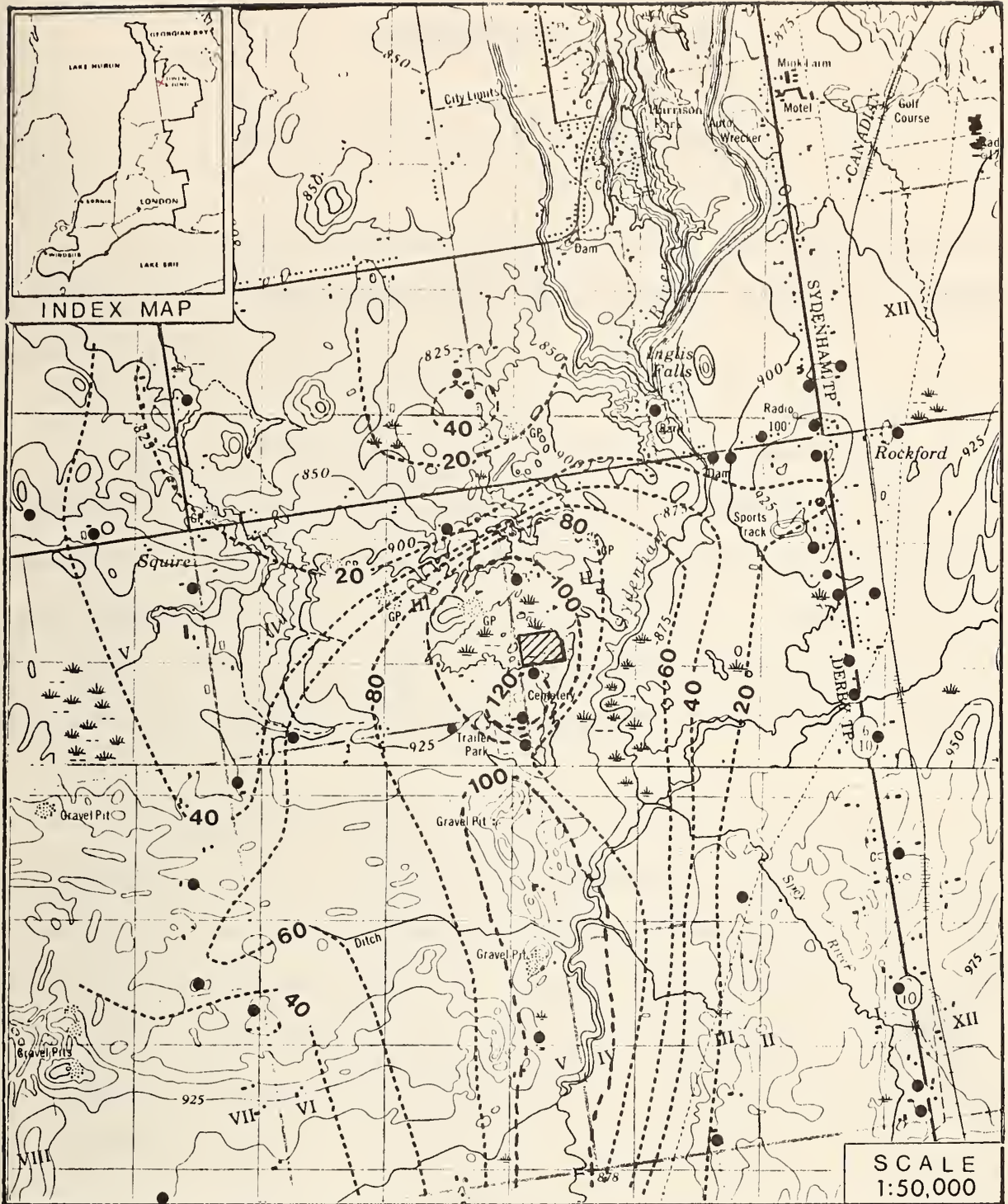
Surficial Deposits

Unconsolidated deposits of Pleistocene Age mantle the bedrock over most of the study area.

The existing sanitary landfill site is located on a kame moraine, which is bounded to the east, northeast and northwest by limestone plains (Chapman and Putnam, 1966). To the north, it is bounded by a steep slopes of the Niagara Escarpment that approach a vertical plane. This moraine was formed by the advance of an ice lobe from the basin now occupied by Georgian Bay.

The kame deposits consist of relatively permeable material and the lithology reported in nearby water wells confirms this. The water well records indicate that the kame moraine is comprised of clayey gravel and stones, sandy clay and stones and fine gravel with large boulders. These materials grade northeastward into outwash deposits of irregularly stratified gravel, sand and silt, (Sobanski, 1975).

The thickness of surficial deposits varies from zero to 124 feet (Figure 3). The zone of maximum thickness has north-south trend and coincides with the position of the previously noted bedrock channel.



LEGEND

- Control point
- Line of equal overburden (isopach)
thickness in feet (interval 20 feet)
- Landfill

FIGURE 3. THICKNESS OF SURFICIAL DEPOSITS.

HYDROGEOLOGY

Bedrock Hydrostratigraphic Unit

A few feet, or a few tens of feet of the upper part of the bedrock are permeable and are considered to comprise a single hydrostratigraphic unit.

Bedrock formations have generally the same lithology and consist of dolomite with minor shale. The bedrock is characterized by a fracture type of porosity irregularly distributed through the rocks. The origin of the fractures in such type of rocks varies, but most of them likely originated during and after glaciation as a result of ice loads applied to the brittle rock.

In carbonate rocks of this sort several types of openings occur that contribute to permeability; (a) vertical joints and fissures in the ancient weathered zone within 10 to 20 feet of the bedrock surface, (b) bedding joints within and below the ancient weathered zone, (c) primary intergranular permeability, perhaps enhanced by solution, and (d) permeability associated with biohermal reefs.

Of 46 wells in the area the records of which are on file with this Ministry (Appendix A), only four wells in the immediate vicinity of the sanitary landfill site obtain water from the overburden. Furthermore, when the hydraulic heads in bedrock wells are contoured, the uniform pattern of piezometric

lines suggests hydraulic continuity between all points. Therefore, it is reasoned that the upper several tens of feet of the bedrock represents a continuous artesian aquifer system.

Overburden Hydrostratigraphic Unit

The surficial deposits are considered a single hydrostratigraphic unit because of relatively similar lithological characteristics. In the general vicinity of the landfill site it consists of poorly sorted clayey and silty sand and gravel, silty gravel and large boulders. Mechanical analyses from boreholes located about 2,500 feet north of the existing landfill, revealed the presence of fine to medium sand at depths 25 and 50 feet (Sobanski, 1975).

Four water wells in the immediate vicinity of the landfill site obtain water from the overburden aquifer which consists of gravel from a depth between 87 and 110 feet below ground surface. The lateral extent of this gravel deposit is unknown, but it is thought to be of limited extent. The gravel occurs immediately above, or a few tens of feet above the bedrock surface and is considered to be hydraulically connected with the bedrock aquifer system. A review of additional water well records in the broader area indicates that the deep sand and gravel aquifer is not everywhere present.

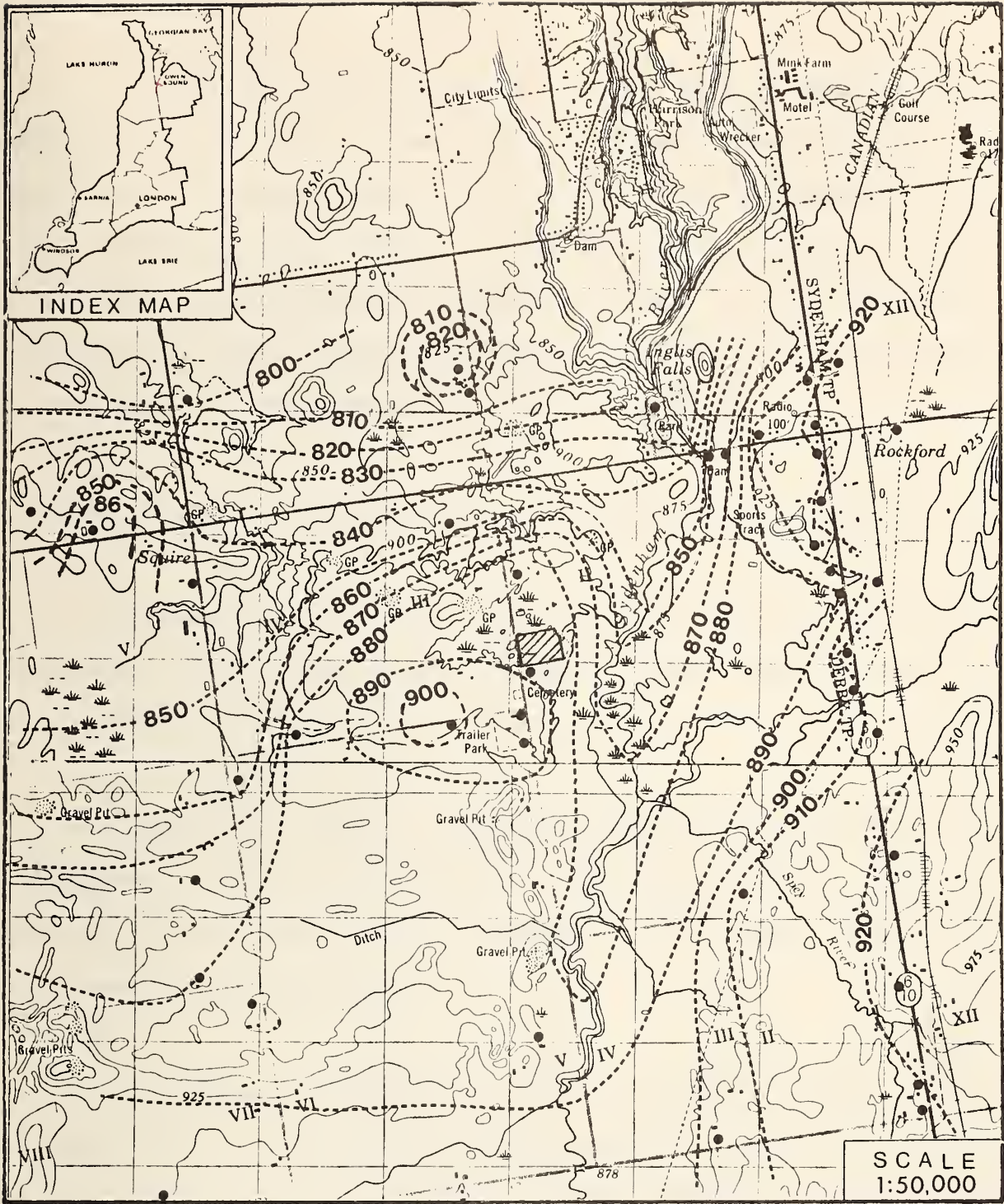
Little is known about the distribution and presence of a shallow water table aquifer in the area. Of six test holes dug to a depth between 10 and 14 feet in 1969 at the existing

landfill site three of them reported water between 8 and 12 feet while the rest of wells were reported dry. A similar situation was reported at the nearby Lincoln Trailer Park. Thus, it is concluded that the continuous shallow overburden aquifer is absent in the study area, and surficial deposits are relatively permeable.

Groundwater Movement in the Bedrock

In order to have a flow in a groundwater reservoir, the water must have, according to Hubbert (1940) an initial store of mechanical energy in the form of fluid potential. Hence, groundwater flows under the influence of gravity following the most direct route from points of higher potential to points of lower potential.

The information from water wells penetrating bedrock were used to infer groundwater flow system in the bedrock aquifer (Figure 4). Contours of equal potential in the bedrock aquifer system give the direction of groundwater flow as well as the distribution of recharge and discharge zones. By definition, closed contours of equal potential in a groundwater mound indicate recharge, or downward movement (Figure 4). Contours of equal potential near or above ground surface indicates a groundwater discharge area.



LEGEND


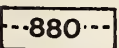

-  Control point
-  Potentiometric contour above sea level, in feet (interval 10 feet)
-  Landfill

FIGURE 4. POTENTIOMETRIC MAP OF THE BEDROCK AQUIFER SYSTEM.

Although, the positions of equipotential lines shown in Figure 5 are somewhat interpretative because of the scarcity of data, it gives general idea of the direction of groundwater flow in the bedrock aquifer system. It is indicative, however, that the existing sanitary landfill site is located in a groundwater recharge area, where groundwater moves downward, then in northerly and easterly directions toward the Sydenham River.

Hydrogeology in the Vicinity of the Owen Sound Landfill

The vertical geologic cross section shown in Figure 5 illustrates hydrogeological environments at the landfill and in nearby wells.

Relatively sparse information indicates absence of a shallow water table over most part of 35 acre landfill. Thus burial of refuse took place in trenches up to 25 feet in depth under unsaturated conditions.

As shown by studies in Illinois (Hughes, Landon, and Farvolden, 1971) infiltration through landfill covers does occur resulting in groundwater mounds within the landfill. Evidence of a mound at the Owen Sound landfill is indicated by the presence of a leachate spring at the toe of the northeast slope of the landfill (Figure 1). Here the leachate migrates laterally from the landfill and flows into the nearby stream and swamp where it undergoes dillution and natural biological breakdown. It is unknown if the leachate represents a perched or true water table.

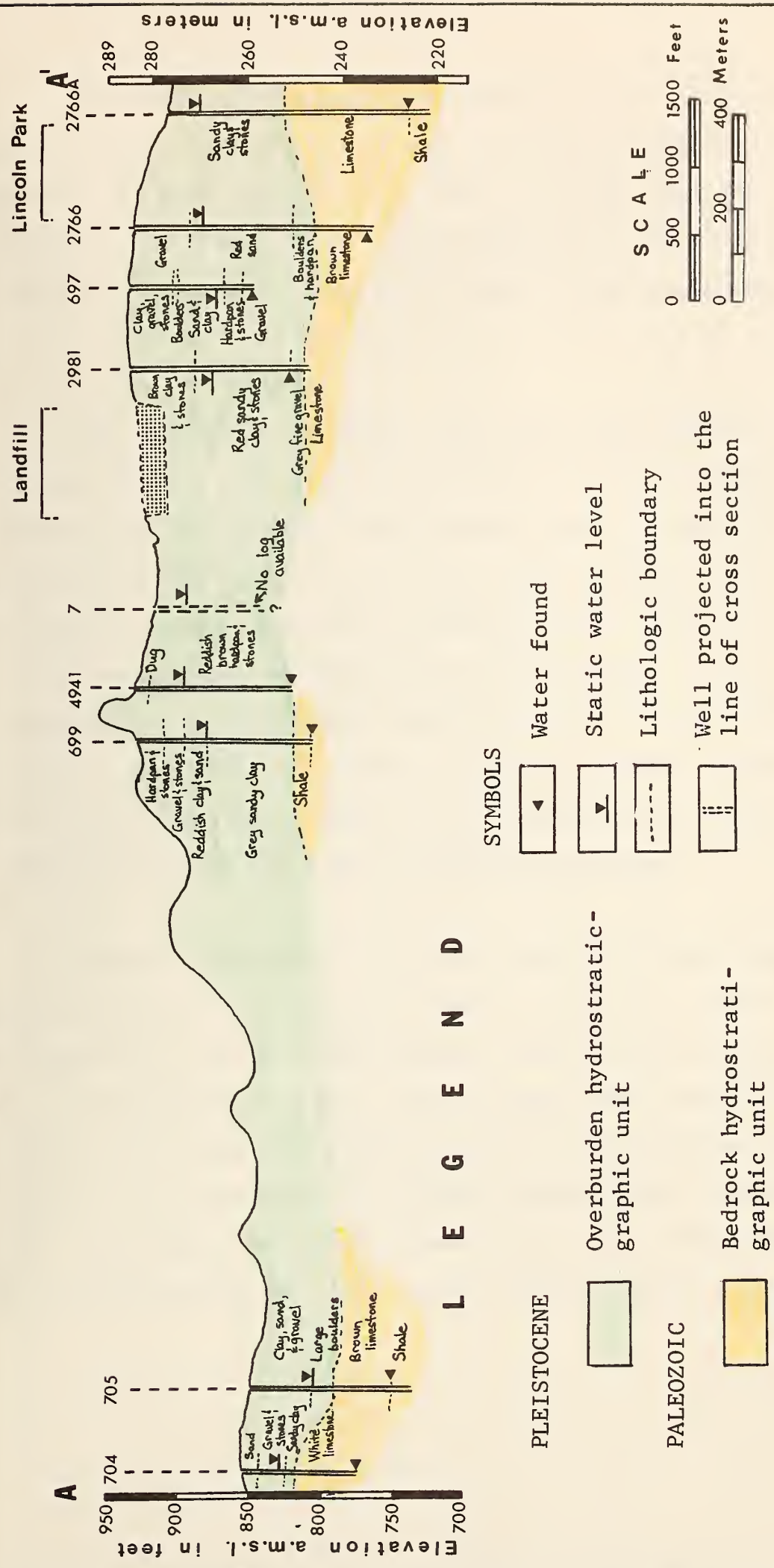


FIGURE 5. CROSS SECTION SHOWING HYDROGEOLOGICAL ENVIRONMENTS IN THE AREA OF THE OWEN SOUND LANDFILL.

Analyses of Sydenham River water in July 1975 demonstrated that water quality above and below the landfill site is essentially the same (Appendix B), and it is felt that the diluting capability of the river is large compared to the relatively small amount of leachate which may be getting into Sydenham River.

The movement of leachate from the refuse toward the bedrock constitutes a potential hazard for the deep overburden and bedrock aquifer systems. Percolation tests carried out in connection with the design of the tile field extension at the Lincoln Mobile Home Park gave infiltration rates varying from 0.1 to 0.25 inches/minute. As the base of the landfill is only 80 feet from the top of the water bearing zone and 90 feet from the bedrock (well No. 2981) the travel time for leachate to reach the bedrock is approximately 8 days. This assumes that these percolation rates apply over the total overburden thickness.

The key question is; to what extent will the physical-chemical interactions between the leachate and intervening glacial materials renovate the leachate and thereby minimize the impact on groundwater quality. The evidence shows that dilution does occur as the leachate passes through the overburden, but this process is insufficient to totally renovate the leachate with the result that the leachate enters the deep overburden-bedrock aquifer system and pollutes the potable water supply.

GENERATION, ATTENUATION AND MIGRATION OF LEACHATE

A minor amount of the leachate is derived immediately after implacement of refuse during the initial compaction and settlement of the refuse. The major portion of it is produced by landfill after a certain period of time when decomposition of refuse reaches its maximum. The intensity of refuse decomposition depends on the initial composition of refuse, the presence or absence of oxygen, time of burial, the age of the landfill, the degree of compaction, the temperature and the moisture content (Hughes, Landon and Farvolden, 1971). Water originating from precipitation will accelerate decomposition and will leach various organic and inorganic substances present in the refuse. Decomposition of refuse is aerobic in the early stages, but soon becomes anaerobic.

The most important gases generated by the landfill are carbon dioxide and methane. They are released both to the atmosphere through cover material and to the surrounding ground and groundwater.

In the course of its migration through the ground the leachate is attenuated by dilution due to the infiltration of uncontaminated water, then ion exchange, dispersion, diffusion, mechanical filtration, sorption, chemical precipitation, gaseous exchange and microbial activity.

Fine-grained sediments have a high capacity for attenuating the contaminants, whereas sands and gravels have less ability to attenuate the components of leachate. The rates of groundwater

flow through fractured rocks is relatively high, but the rock retains relatively small amounts of the contaminants.

A literature review on the impact of leachate on groundwater quality leads to the conclusion that the most obvious changes to be expected are increases in total hardness, alkalinity, calcium, magnesium, sodium, potassium, chloride and sulphate (Zanoni, 1973). Other parameters such as iron, chemical oxygen demand (COD) and biochemical oxygen demand (BOD) may also show increases.

GROUNDWATER QUALITY

In order to establish existing groundwater quality at the landfill site, water quality surveys of the deep overburden-bedrock aquifer systems commenced in October, 1975. The chemical and bacteriological analyses are shown in Appendices B and C. The results show that groundwater quality in the two wells nearest to the landfill site have been affected by leachate generated by the landfill. Thus, original groundwater quality in these two wells could not be established.

Pollution of Domestic Water Supplies

Information indicates that at the present time, two domestic well water supplies in the area (serving three families) have become contaminated from the existing landfill site operation.

Table 1. Selected chemical parameters in the R. Ledingham overburden well (Well No. 7)

Date Sampled	Hardness in mg/l	Chloride in mg/l	Apparent colour Hazen units	Turbidity Formazin units	Phenols in ppb	Petroleum Hydrocarbons mg/l	COD in mg/l	Iron in mg/l	Sulphate as SO ₄ in mg/l
Oct. 20/75						N.D.			
Oct. 22/75	320	60	5	15				1.9	5.0
Oct. 29/75	324	57			7	N.D.	24	2.64	1.0
Nov. 17/75						N.D.			
Nov. 26/75	330	56			<1		9.3	1.36	7.0
Dec. 8/75	314	60	10	11		N.D.	11	1.26	6.5
Dec. 15/75						*			
Dec. 22/75	392	53			5		28	1.40	6.5
Jan. 7/76	320	53	30	26	2		30	2.32	9.0
Feb. 3/76	318	53	5	5.6	<1	N.D.	<2	0.65	8.0
Apr. 6/76	318	53	5	2.6	4		28	0.76	8.0

mg/l - Milligrams per litre or parts per million
ppb - Parts per billion
N.D. - Not detectable
COD - Chemical oxygen demand
* - Two petroleum hydrocarbons components detected
< - Refers to less than

The affected wells and families are located immediately north (Well No. 7) and south (Well No. 2981) of the sanitary landfill site (Figure 1).

The chemical parameters, which are listed in Tables 1 and 2 are considered to be indicators of chemical contamination in the R. Ledingham and the D. Williton - E. Carman domestic wells.

Although prior chemical analyses of groundwater from these two wells are not available, there is no doubt that the concentrations of chemical constituents shown in Tables 1 and 2 are above normal. For comparison, Tables 3 and 4 list the same chemical parameters in two other wells which are considered to be unaffected by the existing landfill site, yet, these two wells obtain water from the same hydrogeological environment.

The concentrations of the same five chemical parameters in the leachate generated by this landfill are indicated in Table 5. The high concentrations of hardness, chloride, sodium, COD, phenols and iron in the leachate is obvious and increases in these parameters in nearby private water supplies is a partial basis for concluding that contamination has originated from the landfill.

Table 2. Selected chemical parameters in the D. Williton - E. Carman bedrock well (Well No. 2981)

Date Sampled	Hardness in mg/l	Chloride in mg/l	Apparent colour Hazen units	Turbidity Formazin units	Phenols in ppb	Petroleum Hydrocarbons mg/l	COD in mg/l	Iron in mg/l	Sulphate as SO ₄ in mg/l
Oct. 22/75	360	34.5		42				3.35	<0.5
Oct. 29/75	340	35				N.D.	251	2.24	<0.5
Nov. 17/75						N.D.			
Nov. 26/76	326	27			22			1.91	2.0
Dec. 8/75	370	33	40	30		N.D.	189	2.7	<0.5
Dec. 15/75						*			
Dec. 22/75	372	36.5			41		253	4.45	2.0
Jan. 6/76	336	33.5	100				227	3.2	2.0
Jan. 7/76	304	33	75		35		214	2.9	1.5
Feb. 3/76	312	23.0	30	22	20	N.D.	103	1.90	3.0
Apr. 6/76	392	51	100	54	59		345	5.0	1.0

* - Two petroleum hydrocarbons components detected

Table 3. Selected chemical parameters in the L. Williton overburden well (Well No. 697)

Date Sampled	Hardness in mg/l	Chloride in mg/l	Apparent colour Hazen units	Phenols in ppb	COD in mg/l	Iron in mg/l	Sulphate as SO ₄ in mg/l
Nov. 26/75	310	4.0		<1	<2	0.03	38.0
Dec. 8/75		3.5	<5		<2	0.04	37.0
Feb. 3/76	316	3.5	<5	<1	<2	<0.02	38
Apr. 6/76	306	4.0	<5	3	17	0.06	37.5

Table 4. Selected chemical parameters in the Lincoln Park bedrock well (Old Well;No. 2766)

Date Sampled	Hardness in mg/l	Chloride in mg/l	Apparent colour Hazen units	Turbidity Formazin units	Phenols in ppb	COD in mg/l	Iron in mg/l	Sulphate as SO ₄ in mg/l
Apr. 25/75	294	4.0	<5	0.35			0.05	
Sept. 17/75	286	5.5	<5	0.40			0.13	
Nov. 26/75	312	5.5			<1	<2	0.01	31.5
Dec. 8/75		5.0	<5			<2	<0.01	31.5
Dec. 30/75	298	4.5	<5	0.20			0.01	31.5
Jan. 7/76	300	4.5	<5	0.25			<0.01	30.0
Feb. 3/76	296	4.5	<5	0.25	<1	<2	<0.01	31.5
Apr. 6/76	298	5.0	<5	0.20	<1	15	<0.01	33.0

Table 5. Concentrations of selected chemical parameters in the leachate

Date Sampled	Hardness in mg/l	Chloride in mg/l	COD in mg/l	Phenols in ppb	Iron in mg/l
July 9/75	1700	2500	19000		1500
Nov. 5/75		900			
Jan. 7/76	1720	975	7430	1750	770
Feb. 18/76	1620	1100	7088	1475	600
Apr. 6/76	1460	1125	3701	1025	220

Some of the other factors already discussed which contribute to the present problems are summarized below:

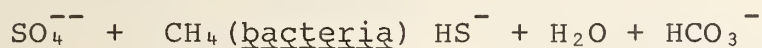
1. The sanitary landfill site is located in relatively permeable surficial deposits.
2. The attenuation of leachate components by the surficial materials is not intensive and negligible in the bedrock.
3. To date, water quality has deteriorated in two well nearest to the waste disposal site.

INTERPRETATION OF GROUNDWATER QUALITY

Groundwater chemistry in the area suggests that the dominant controlling mechanisms are (a) dilution, and (b) a combination of sulphate reduction and carbonate buffering. In order to better understand the distribution pattern and its controlling mechanisms further calculations of the activities of the dissolved species in the calcite-dolomite-water system

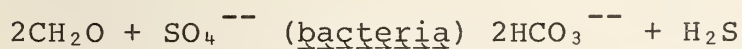
are necessary taking into account saturation indices for these minerals. This may involve use of a computer and is not within the scope of this report. However, the observed changes in groundwater chemistry point to the chemical reactions which may be superimposed on the carbonate equilibrium system.

The chemical reaction which is taking place here is sulphate reduction. This process is incompletely understood and partly depends on the form of available organic carbon. According to Hem (1959) methane reduction may proceed as:



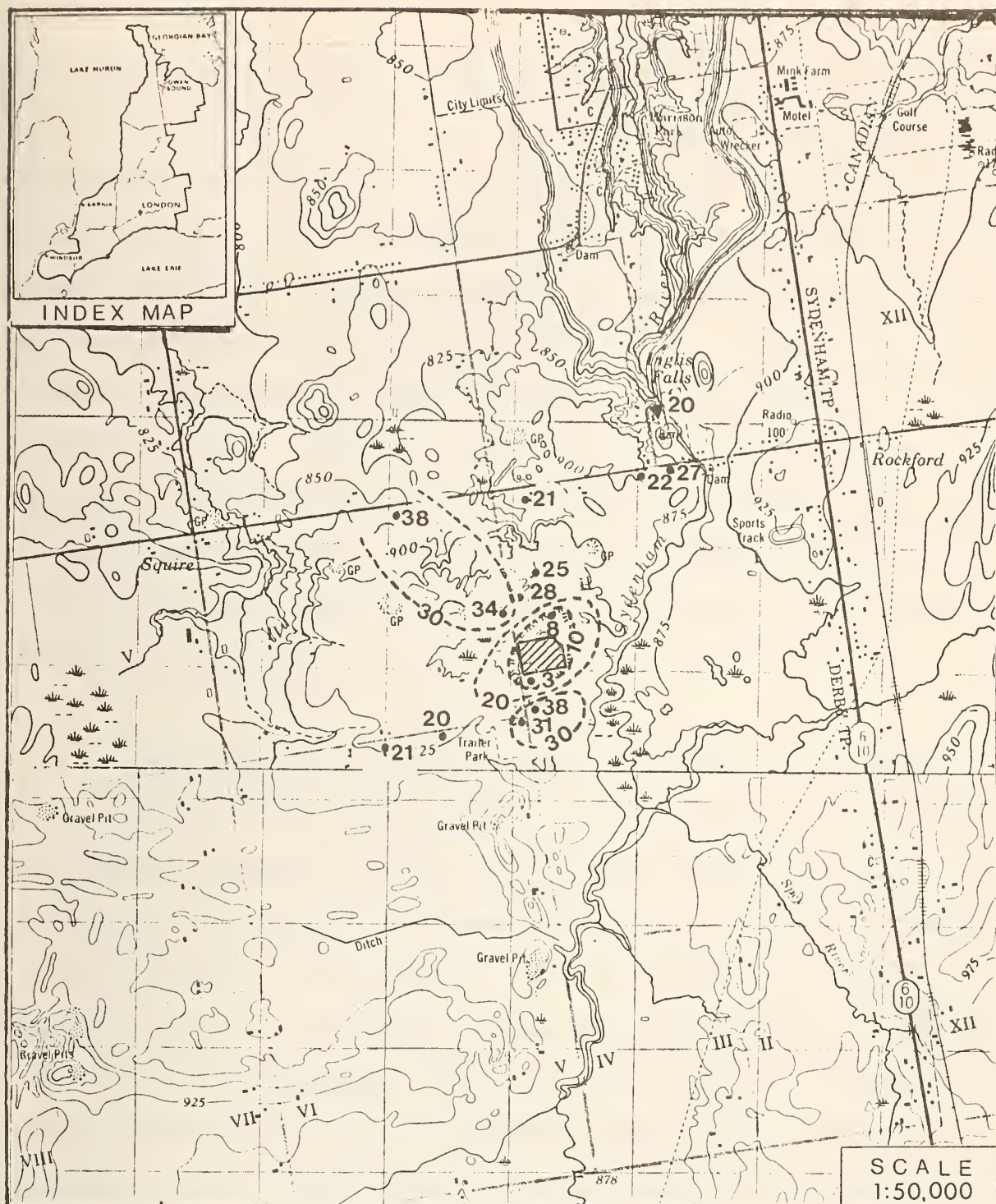
which yields one mole of HCO_3^- for each mole SO_4^{--} reduced.

Another type of sulphate reaction discussed by many authors (e.g. Sholkovitz, 1973; Sayles and Manheim, 1975; Kunkle and Shade, 1976) is:



where CH_2O represents sources of organic carbon, and results in a two to one increase in bicarbonate to sulphate. Increases in bicarbonate levels are reflected in large alkalinity concentrations in the affected wells.

The existence of sulphate reduction processes in the vicinity of the landfill site is confirmed by the recent bacteriological analyses which indicated increased concentration of sulphate reducing bacteria in three nearest wells to the landfill (Appendix C). Furthermore, as expected from the sulphate



LEGEND

- , ▼ 20 Sampled deep overburden-bedrock well and spring with value of SO₄ in mg /l
- 20--- Contour of equal concentration of SO₄ in mg/l
- ▨ Landfill

FIGURE 6. HYDROCHEMICAL MAP OF THE SULPHATE DISTRIBUTION IN THE DEEP OVERBURDEN-BEDROCK AQUIFER SYSTEM.

hydrochemical map (Figure 6) the lowest sulphate concentrations occur in the immediate vicinity of the landfill. Thus, it is postulated that the reducing environment within the landfill has been transferred to the deep overburden-bedrock aquifer system thereby stimulating the observed ongoing sulphate reduction in the wells. The chemistry of sulphate reduction is extremely sensitive to a small changes in oxygen content (Sholkovitz, 1973). Oxygen contents of 0.3 to 0.4 mg/l are sufficient to oxidize organic material which, in turn, will halt sulphate reduction. When the oxygen content falls below 0.1 mg/l and the environmental factors are conducive, sulphate reduction will proceed.

The two most prevalent gases generated in the landfill are methane and carbon dioxide, which could produce sufficient positive pressure to migrate ahead and perhaps upward of the groundwater gradient and reach the bedrock aquifer and domestic wells ahead of the leachate. Methane aids the sulphate reduction process by providing carbon and hydrogen for production of bicarbonate and hydrogen sulphide. Carbon dioxide in water solution reacts with calcium carbonate present in glacial materials directly beneath the landfill, liberating calcium and bicarbonate ions throughout the overburden section.

CONCLUSIONS

Analyses of geological and hydrogeological data at the Owen Sound landfill indicate that relatively complex hydrogeological conditions exist at this landfill. The site is

situated on a kame moraine with a thickness of about 100 feet. Kame deposits are relatively permeable and the lithology reported in nearby water wells confirms this. Because of this, the kame deposits are considered relatively poor sites for landfill. Dolomite, with locally reported shale layers which belong to Guelph-Lockport Formation, underly the area.

Groundwater quality monitoring over an area of 11 square miles in the vicinity of the Owen Sound landfill included 20 wells and two springs, provided sufficient data to document background groundwater quality characteristics as well as pronounced quality changes in the nearby domestic wells.

The reduction in sulphate concentrations together with increases in hardness and alkalinity in the deep overburden and carbonate aquifer system in the vicinity of the landfill appear to be related to the sulphate reduction reaction which are created by the landfill leachate. Furthermore, the increases in chloride, sodium, iron, COD and presence of phenols and tannins and lignins in two wells located in the immediate vicinity of the disposal site is directly related to the introduction of these chemical constituents into the aquifer system by the leachate.

The presence of the Owen Sound landfill poses a further threat to the other domestic wells in the area because the pollution front is expected to continue to spread and to adversely affect additional domestic water supplies.

RECOMMENDATIONS

It is obvious from our investigations that pollution of two water wells has occurred and that this pollution has originated from the Owen Sound sanitary landfill. It is our opinion that Sections 31 and 32 of the Ontario Water Resources Act have been violated and in this matter we are seeking the advice of our Legal Branch.

It has been our policy to pursue situations of water quantity interference under Section 37 of the Ontario Water Resources Act by acting as an intermediary in seeking restoration of the affected water supplies. We see a parallel situation here where water quality "interference" has occurred and as a matter of policy we wish to employ the OWR Act as a means of (a) seeking restoration of affected water supplies, (b) repayment of cost resulting from the interruption of water supply and (c) undertaking an environmental rehabilitation for pollution of the aquifer system.

It is recommended that the City of Owen Sound make further efforts to find an environmentally acceptable sanitary landfill site and terminate use of present one. In order to lessen potential contamination of the other neighbouring domestic wells and groundwater in general it is recommended that efforts be directed to reducing of the amount of the leachate which the site generates. In this regard a planted and compacted clay cover is recommended together with contoured

finished grade which will reduce infiltration into landfilled waste and generation of leachate.

Furthermore, the environmental rehabilitation of the contaminated aquifer should consist of drilling and subsequent pumping of several wells downgradient from the landfill with an attempt to remove pollutants from groundwater and restrict its further migration. To this end, it is recommended that the City hire a qualified hydrogeologist and seeks his opinion in this matter. Details and procedure of remedial measures remains to be worked out by a consulting hydrogeologist in close consultation with this Ministry.

Meanwhile, this Ministry will continue to monitor groundwater quality in the neighbouring wells and the City of Owen Sound will be informed of any additional development.

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APPENDIX A
SUMMARY OF WATER WELL RECORDS

SUMMARY OF WATER WELL RECORDS

COUNTY: GREY TOWNSHIP(S): DERBY DATE COMPILED: 3/16/76 COMPILER: K. LYON

WELL NO.	LOCATION			ELEV. (FT)	OWNER	DRILLER	DATE PUMPED	WELL TYPE	WELL DIA. (IN.)	WELL DEPTH (FT.)	WATER FOUND (FT)	STATIC LEVEL (FT.)	PUMPING TEST			WATER TYPE	LOG AND REMARKS
	TWP.	LOT	CON.										DRAW-DOWN (FT.)	G.P.M.	HRS.		
652		1	I	925	W. LAIRD	C. BARTLEY	05/50	DR.	4	25	25	12	5	15	1	F	0-1 topsoil 1-12 yellow clay 12-25 limestone
653		1	I	927	C. CRUISE	D. WRIGHT	12/64	DR.	5	33	25-36	8	7	10	2	F	0-5 clay 5-20 loose limestone 20-33 brown limestone
3445		2	I	935	R. MORRISON	R. & S. WRIGHT	05/71	DR.	5	75	55	10	50	10	1	F	0-7 1/2 brown topsoil 37 1/2 -50 br. limestone 7 1/2-29 brown limestone 50-60 grey limestone 29-37 1/2 brown clay 60-75 blue limestone
4234		4	I	920	SUNNY-VALLEY PARK	A. LOUCKS	07/73	DR.	6	60	50	6		8	3	F	0-15 stones and gravel 15-55 white limestone 55-60 brown limestone
655		6	I	912	A. WAKDELL	D. WRIGHT	12/64	DR.	5	86	50-80	6	54	10	2	F	0-25 loose limestone 25-86 greyish-white limestone
654		6	I	913	H. BELL	M. BELLERBY	05/61	DR.	5	87	77-87	1	could easily pump dry	3/4	~2	F	0-16 broken loose rock 16-87 grey limestone
657		7	I	894	R. HEFT	R. & S. WRIGHT	11/59	DR.	4	87	87	4	21	10	1	F	0-1 topsoil 1-25 white lime 25-87 blue lime
662		8	I	900	W. MCNABB	L. & A. WRIGHT	07/54	DR.	4	40	35	8	32	18	1	F	0-5 soil 5-40 limestone
661		8	I	923	J. CROSSLEY	L. & A. WRIGHT	07/54	DR.	5	121	116	21	100	12	1	F	0-12 soil 12-121 limestone
664		9	I	932	H. METZGER	R. & S. WRIGHT	11/60	DR.	4	116 1/2	115	20	40	15	1	F	0-16 well dug 16-25 hard pan clay 25-50 grey limestone
668		9	I	928	W. COOK	R. & S. WRIGHT	07/66	DR.	5	95	52	18	72	2	1 1/2	F	0-15 brown soil and stones 15-95 blue limestone

SUMMARY OF WATER WELL RECORDS

COUNTY: GREY TOWNSHIP(S): DERBY DATE COMPILED: 3/03/76 COMPILER: K. LYON

WELL NO.	LOCATION		ELEV. (FT)	OWNER	DRILLER	DATE	WELL TYPE	WELL DIA (IN)	WELL DEPTH (FT.)	WATER FOUND (FT)	STATIC LEVEL (FT)	PUMPING TEST			WATER TYPE	LOG AND REMARKS
	TWP	LOT										CON.	DRAWN-DOWN (FT)	G.P.M.		
663		9	I	S. KELLING	D. WRIGHT	04/53	DR.	4	50	48	6	24	5	2	F	0-6 yellow clay 6-50 limestone rock
665		9	I	H. LAMB	R.S. WRIGHT	04/62	DR.	4 1/2	77	75	15	60	3 1/2	2	F	0-4 top soil 4-35 grey limestone 35-77 blue limestone
676		10	I	W. HICKS	D. WRIGHT	04/63	DR.	5	80	40-70	5	65	5	2	F	0-7 loose rock 7-80 hard grey & blue limestone
677		10	I	M. HARRIS	D. WRIGHT	10/63	DR.	5	161	80, 115	12	68	5	4	F	0-6 brown clay 6-110 grey limestone 110-116 blue shale
675		10	I	J. KEELING	R.S. WRIGHT	04/62	DR.	4	108	90-108	12	93	1 1/4	2	F	0-2 top soil 2-56 grey limestone 56-100 brown limestone 100-102 blue shale 102-108 red shale
3783		1	II	N. TRIBBLE	A. LOUCKS	10/71	DR.	6	69	60	31	4	8	12	F	0-14 clay, gravel, and stones 14-69 brown limestone
697		7	II	L. WILLITON	R.S. WRIGHT	04/62	DR.	5	87	87	60	0	20	1 1/2	F	0-30 clay, gravel, stones 30-33 small boulders 33-66 sand & clay 66-78 hardpan & stones 78-82 fine gravel 82-87 coarse gravel
2981		7	II	D. WILLITON	R.S. WRIGHT	08/69	DR.	5	125	110	53	4	15	1 1/2	F	0-44 brown clay & stones 44-110 red sandy clay & stones 110-120 grey fine gravel 120-125 broken limestone
4941		8	II	E. CAMERON	R.S. WRIGHT	04/74	DR.	5	110	110	35	10	7	1	F	0-5 dug 5-10 brown sand 10-110 reddish brown hardpan & stones
698		8	II	I. FRANKLIN (former owner E. CAMERON)	R.S. WRIGHT	07/58	DR.	4 1/2	89	89	30	55	5	1	F	0-4 top soil 4-10 sand & clay 10-30 big stones & gravel 30-40 fine sand 40-47 hardpan & boulders 47-60 fine sand 60-80 gravel & small stones 80-89 gravel & water

SUMMARY OF WATER WELL RECORDS

COUNTY: GREY TOWNSHIP(S): DERBY DATE COMPILED: 3/10/76 COMPILER: K. LYON

WELL NO.	LOCATION			ELEV. (FT.)	OWNER	DRILLER	DATE	WELL TYPE	WELL DIA. (IN.)	WELL DEPTH (FT.)	WATER FOUND (FT.)	STATIC LEVEL (FT.)	PUMPING TEST			WATER TYPE	LOG AND REMARKS
	TWP.	LOT	CON.										DRAW-DOWN (FT.)	G.P.M.	HRS.		
699		8	II	938	W. MOULTON	R. & S. WRIGHT	09/59	DR.	4	124	124	50	30	10	2	F	0-10 hardpan & stones 50-110 gray sandy clay 20-35 gravel & stones 110-122 red shale 35-50 reddish clay & sand 122-124 shaly bedrock
3883		10	II	870	W. SMITH	A. LOUCKS	05/72	DR.	5	100	75	44	10	10	3	F	0-14 clay and gravel 14-75 white limestone 75-100 rock and shale
703		2	III	900	WILSON	D. WRIGHT	10/64	DR.	5	154	145	19	5	7	2	F	0-23 dug well 112-145 grey limestone 23-45 gravel 145-154 brown limestone 45-112 hardpan
2766A		6	III	912	LINCOLN TRAILER PARK (new well)	R. & S. WRIGHT	09/75	DR.	5	180	165	18	30	36	9	F	0-80 sandy clay & stone 172-180 red shale 80-166 limestone 166-172 blue shale
3630		6	III	930	H. GELIES	W. WRIGHT	07/71	DR.	5	123	116	23	0	14	2	F	0-15 clay & gravel 90-123 light brown limestone 15-83 red sand & clay 83-90 gravel
2766		6	III	935	LINCOLN TRAILER PARK (old well)	W. WRIGHT	11/68	DR.	5	165	160	45	2 1/2	14	2	F	0-40 gravel 124-165 brown limestone 40-110 red sand 110-124 boulders & hardpan
4427		8	III	923	N. BARBER	W. WRIGHT	11/73	DR.	5	97	97	12	18	14	2	F	0-97 gravel
706		9	III	865	G. LEDDINGHAM	M. BELLERBY	07/48	DR.	5	80	80	22	0	10?	1	F	0-16 clay and stones 16-80 rock
705		11	III	850	B. BELROSE	D. WRIGHT	04/64	DR.	5	114	90-106	45	0?	12	2	F	0-45 clay sand & gravel 100-106 blue shale 45-60 large boulders 106-114 red shale 60-100 brown limestone
704		11	III	850	B. BELROSE	D. WRIGHT	11/56	DR.	4	80	80	25	10	5	1/2	F	0-10 sand 36-80 white limestone 10-30 gravel & stones 30-36 sandy clay
3336		6	IV	875	W. KING	W. WRIGHT	11/70	DR.	5	225	80, 220	25	95	14	2	F	0-35 clay, hardpan, boulders 35-215 brown limestone 215-225 dark brown limestone

SUMMARY OF WATER WELL RECORDS

COUNTY: GREY TOWNSHIP(S): DERBY, SYDENHAM DATE COMPILED: 3/63/76 COMPILER: K. LYON

WELL NO.	LOCATION		ELEV. (FT)	OWNER	DRILLER	G.P.M.	WELL TYPE	WELL DIA. (IN.)	WELL DEPTH (FT)	WATER FOUND (FT)	STATIC LEVEL (FT)	PUMPING TEST		WATER TYPE	LOG AND REMARKS	
	TWP.	LOT										CON.	DRAW-DOWN (FT)			G.P.M.
2839	D	7	IV	V. FARROW	R. & S. WRIGHT	04/69	DR.	5	90	85	13	67	10	1	F	0-10 sandy soil 10-69 grey clay and stones 69-90 brown limestone
752	D	11	IV	L. VANCE	R. & S. WRIGHT	10/59	DR.	4	62	62	12	8	10	1	F	0-4 top soil 4-40 grey limestone 40-62 blue limestone
780	D	1	V	A. KUHLE	A. LOUCKS	11/65	DR.	5	42	35-42	8	10	15	5	F	0-26 clay and gravel 26-42 limestone
781	D	3	V	W. BEATON	R. & S. WRIGHT	09/50	DR.	4	52 1/2	50	15		5	1/2	F	0-25 gravel and clay 25-33 clay 33-52 1/2 limestone
782	D	4	V	M. JOHNSON	R. & S. WRIGHT	08/57	DR.	4	95	95	20	5	10	1	F	0-30 dug well 30-50 stones; gravel 50-60 hard pan; boulders 60-95 grey limestone
4586	D	5	V	W. KING	W. WRIGHT	03/74	DR.	5	120	70-112	26	14	14	2	F	0-53 clay, gravel, boulders 53-120 limestone
783	D	9	V	C. BARFOOT	R. & S. WRIGHT	02/65	DR.	5	73 1/2	70	21	0	15	1/2	F	0-17 brown sandy clay 17-33 brown sand 33-60 brown limestone 60-73 1/2 grey limestone
784	D	10	V	T. VOKES	R. & S. WRIGHT	12/60	DR.	4	138	90-138	52	62	5	1	F	0-4 top soil 4-20 gravel; stones 20-44 big boulders; half pan 44-85 grey limestone 85-112 blue limestone 112-138 grey limestone
4825	D	10	V	S. STRALTON	W. WRIGHT	08/74	DR.	5	225	140, 215	28	92	5	2	F	0-37 clay, gravel with boulders 37-225 limestone
2521	S	4	XII	M. HAMILTON	D. WRIGHT	09/61	DR.	5	81	75	10	18	12	2	F	0-12 clay and boulders 12-81 brown limestone
4132	S	6	XII	CASHWAY LUMBER	R. & S. WRIGHT	04/73	DR.	5	100	94	4	21	5	1	F	0-8 brown gravel; stones 8-88 white limestone 88-94 brown limestone 94-100 blue shale

APPENDIX B
CHEMICAL ANALYSES

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 1	V. Wilson	26/11/75	330	278		530	7.43					1.9	0.9	54	27.5	0.005	0.125	0.001	1.47	0.017	0.013	0.08	1
"	"	09/02/76	272	258			7.53	<5	1.0	79	23.2	16.0	1.4	7	27.0				2.9			0.08	
2	R. Farrow	26/11/75	288	254		515	7.46					14	1.1		22.5	0.005	0.105	0.001	1.21	0.004	0.003	0.01	1
3	W. G. Beckett	17/02/76	288	258		550	7.50	<5	0.20	74	28	4.6	1.2	11.5	17	<0.005	0.105	0.001	2.7	0.012	0.007	0.26	<1
4	C. Byers	26/11/75	282	246		510	7.66					2.1	1.2	4.0	21.5	0.005	0.065	0.001	1.69	0.004	0.003	0.05	<1

* Location is shown in Figure 1; < - Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 1	V. Wilson	26/11/75				2	0.01	1.4	0.09	0.01	0.01	0.01	0.03					
"	"	09/02/76				2												
2	R. Farrow	26/11/75					0.01	1.5	0.06	0.01	0.01	0.01	0.03					
3	W. G. Beckett	17/02/76	<0.1	<0.02		3.8												
4	C. Byers	26/11/75				<2	<0.01	0.29	0.02	<0.01	<0.01	<0.01	<0.03					

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; < - Refers to less than

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total Kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 5	J. Smith	17/02/76	290	239		535	7.67	<5	0.25	62	34.6	2.2	0.9	5.0	38.0	<0.005	<0.075	<0.001	0.69	0.003	0.002	0.04	<1
G98	I. Franklin	06/03/75	412	250			7.2							19.0		0.02	0.12	0.006	4.8	0.012	0.011	<0.05	
"	"	18/02/76	404	356		820	7.29	<5	0.40	112	30.0	9.6	16.6	20.0	25.5	<0.005	0.185	0.002	8.7	0.006	0.002	0.04	<1
4941	E. Cameron	20/10/75	296	258			7.70	<5	2.1			2.0	0.8	2.5	24.5				0.73			0.32	
"	"	26/11/75	288	262		530	7.71					1.9	0.9	2.5	27.5	0.030	0.060	0.001	0.33	0.001	0.001	0.66	<1
"	"	08/12/75		303			7.94	<5			34		1.0	2.5	28	0.015	0.045	0.002				0.3	
"	"	03/02/76	328	248	248	525	7.64	<5	2.8	55	34	1.8	0.8	2.0	28.5				0.68			0.40	<1

* location is shown in Figure 1; < - Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification Number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 5	J. Smith	17/02/76	<0.1	<0.02		<2												
698	I. Franklin	06/03/75																
698	I. Franklin	18/02/76	<0.1	<0.02		3.8								0	98	1	99	N.D.
4941	E. Cameron	20/10/75																
4941	E. Cameron	26/11/75				<2	<0.01	0.11	0.01	<0.01	<0.01	0.2	<0.03					
"	"	08/12/75			1.1	<2												
"	"	03/02/76		<0.02		<2								0	64	24	88	N.D.

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well																							
4941	E. Cameron	06/04/76	294	260		530	7.66	<5	3.2	62	36.0	2.0	0.8	2.0	28.5	0.015	0.075	0.001	0.58	0.011	0.006	0.38	<1
4427	N. Barber	20/10/75	288	252			7.71	<5	5.1			2.0	0.9	2.0	30				<0.01			0.57	
"	"	26/11/75	278	244		500	7.56					2.0	1.0	2.0	33.5	0.005	0.025	0.001	<0.01	0.004	0.003	0.43	<1
"	"	03/02/76	300	263	263	520	7.63	<5	6.0	56	35.2	1.9	0.9	2.0	34.0				<0.01			0.73	<1
"	"	06/04/76	288	251		520	7.65	15	7.9	57	36.0	2.0	1.0	2.0	34.5	0.005	0.065	0.001	<0.01	0.008	0.004	0.70	<1
7	R. Ledingham	20/10/75																					
"	"	22/10/75	320	277			7.67	5	15			18.8	1.0	60	5				<0.01			1.9	
"	"	29/10/75	324	278			7.89					17.8	1.1	57	1.0	<0.001	0.125	<0.001	<0.01	0.001	<0.001	2.64	7

* location is shown in Figure 1; < Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 44441	E. Cameron	06/04/76	<0.1	<0.02		9.0												
4427	N. Barber	20/10/75	<0.1															
"	"	26/11/75				<2	<0.01	0.25	<0.01	<0.01	<0.01	0.04	<0.03					
"	"	03/02/76		<0.02		<2								0	62	6	68	N.D.
"	"	06/04/76	<0.1	<0.02		17												
7	R. Ledingham	20/10/75																N.D.
"	"	22/10/75	<0.1															
"	"	29/10/75		0.06		24												N.D.

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total Kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 7	R. Ledingham	03/11/75																					
"	"	17/11/75																					
"	"	26/11/75	330	280		690	7.64							56								1.36	<1.0
"	"	08/12/75	314	285		720	7.82	10	11	85	32.8	21.1	1.1	60	6.5	0.005	0.155	0.003	<0.01			1.26	
"	"	15/12/75																					
"	"	22/12/75	392	383			7.60							53								1.40	5
"	"	07/01/76	320	273			7.65	30	26			17.3	1.0	53	9.0				0.01	0.004	0.003	2.32	2
"	"	03/02/76	318	294	294	680	7.56	5	5.6	64	32.4	18.4	0.9	53	8.0	0.01	0.150	0.002	<0.01	0.004	0.001	0.65	<1
"	"	06/04/76	318	275		665	7.57	5	2.6	75	32.8	16.4	1.0	53	8.0	0.005	0.145	0.003	0.03	0.005	0.001	0.76	4

* location is shown in Figure 1; < - Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

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(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 7	R. Ledingham	03/11/75					<0.02	0.05	<0.02	<0.01	<0.01	0.40	<0.02					
"	"	17/11/75																N.D.
"	"	26/11/75				9.3	<0.01	0.05	<0.01	0.01	<0.01	0.44	0.03					
"	"	08/12/75			5.4	11												N.D.
"	"	15/12/75																⊕
"	"	22/12/75				28												
"	"	07/01/76				30												
"	"	03/02/76		<0.02		<2								0	62	18	80	N.D.
"	"	06/04/76	<0.1	<0.02		28												

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than; ⊕ - Two petroleum hydrocarbon components detected.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

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Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P _i		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well																							
2981	D. Williton E. Carman	22/10/75	360	307			7.71	+	42			41.5	0.6	34.5	<0.5			<0.01				3.35	
"	"	29/10/75	348	313			7.87					280	0.7	35.0	<0.5	0.005	0.200	0.001	<0.01	0.033	0.003	2.24	
"	"	03/11/75																					
"	"	17/11/75																					
"	"	26/11/75	326	293		670	7.73					29	0.6	27.0	2.0	0.005	0.115	0.001	<0.01	0.025	0.003	1.91	22
"	"	08/12/75	370	300		720	7.84	4	30	57.5	46	34.5	0.8	33	<0.5	0.005	0.130	0.003	<0.01			2.7	
"	"	15/12/75																					
"	"	22/12/75	372	401			7.65					42.5	0.7	36.5	2.0							4.45	41

* location is shown in Figure 1; + - Interference; < - Refer to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 2																		
2981	D. Williton E. Carman	22/10/75	<0.1															
"	"	29/10/75				251												N.D.
"	"	03/11/75					0.01	0.14	0.01	<0.01	0.01	0.02	<0.02					
"	"	17/11/75																N.D.
"	"	26/11/75					<0.01	0.06	<0.01	<0.01	<0.01	0.01	<0.03					
"	"	08/12/75			715	189												N.D.
"	"	15/12/75																⊕
"	"	22/12/75				253												

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than; > - Refers to greater than; ⊕ - Two petroleum hydrocarbon components detected.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total Kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 2981	D. Williton E. Carman	06/01/76	336	286			7.6	100	39	58		36		33.5	2.0				<0.01			3.2	
"	"	07/01/76	304	287			7.74	75	37			33	0.6	33	1.5				0.01	0.006	0.005	2.9	35
"	"	03/02/76	312	289	289	635	7.71	30	22	54	43.5	21.6	0.6	23	3.0				<0.01			1.90	20
"	"	06/04/76	392	320		875	7.57	100	54	71	52.5	48	0.6	51	1.0	0.005	0.230	0.001	<0.01	0.091	0.004	5.0	59
8	W.B. McKay	17/02/76	332	296		610	7.44	<5	0.20	82	31.8	2.0	0.9	4	8.0	<0.005	0.075	<0.001	5.7	0.004	0.003	<0.01	<1
697	L. Williton	26/11/75	310	262		555	7.64					2.0	1.1	4.0	38.0	0.005	0.045	0.001	0.76	0.012	0.009	0.03	<1
"	"	08/12/75		263		560	7.96	<5			36.8			3.5	37	<0.005	0.020	0.001				0.04	

* location is shown in Figure 1; <- Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 2981	D. Williton - E. Carman	06/01/76				227												
"	"	07/01/76				214												
"	"	03/02/76		0.15		103								1	54	54	108	N.D.
"	"	06/04/76	<0.1	<0.02		345												
8	W.B. McKay	17/02/76	<0.1	<0.02		23												
697	L. Williton	26/11/75					0.01	0.09	0.05	0.01	0.01	0.01	0.03					
"	"	08/12/75			1.0	<2												

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

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(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 697	L. Williton	03/02/76	316	251	251	550	7.64	<5	6.3	60	37.2	1.9	1.3	3.5	38				0.68			0.07	<1
"	"	06/04/76	306	259		550	7.65	<5	7.9	62	37.5	1.8	1.1	4.0	37.5	<0.005	0.045	<0.001	0.67	0.008	0.004	0.06	3
2766	Lincoln Park (well #1, old well)	25/04/75	294	245			7.7	<5	0.35					4.0								0.05	
"	(sample taken at c. 6m below top of well)	17/09/75	286	256			7.96	<5	0.40					5.5				2.0				0.13	
"	"	26/11/75	312	253		560	7.66					3.0	2.0	5.5	31.5	0.005	0.025	0.004	3.0	0.003	0.002	0.01	<1
"	sample taken at well head	08/12/75		258		560	7.97				31.4			5.0	31.5	0.005	0.015	0.006				0.16	
"	c. 6m below top of well	08/12/75		259		560	7.96				30.8			5.0	31.5	0.005	0.015	0.007				<0.01	
"	sample taken at well head	30/12/75	300	252			7.69	<5	0.15					5.0	31.5	0.005	0.025	0.005	3.4			0.01	

* location is shown in Figure 1; < - Refers to less than

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 697	L. Williton	03/02/76		<0.02		<2								0	58	10	68	N.D.
"	"	06/04/76	<0.1	<0.02		17												
2766	Lincoln Park (well #1; old well)	25/04/75	<0.1															
		17/09/75	<0.1															
		26/11/75				<2	<0.01	0.32	<0.01	<0.01	<0.01	<0.01	<0.03					
		08/12/75																
		08/12/75																
		30/12/75	<0.1															

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 2766	Lincoln Park (well #1; old well)	30/12/75	298	251			7.67	<5	0.20					4.5	31.0	0.005	0.070	0.005	3.30			0.01	
"	Sample taken at Gates Kitch. top.	07/01/76	300	250			7.70	<5	0.25			3.0	1.9	4.5	30.0				3.70	0.004	0.003	<0.01	<1
"	"	03/02/76	296	247	247	550	7.55	<5	0.25	66	32.0	3.1	1.8	4.5	31.5				2.7			<0.01	<1
"	"	06/04/76	298	252		555	7.53	<5	0.20	68	34.0	2.6	1.8	5.0	33.0	<0.005	0.055	0.004	2.80	0.003	0.002	<0.01	<1
9	J. Butler	17/02/76	236	215		437	7.76	2.0	12	47	31.0	2.5	0.8	1.5	21.5	0.010	0.050	<0.001	0.01	0.006	0.003	0.88	<1
10	B. Heefling	17/02/76	212	192		407	7.89	<5	0.75	42	27.4	4.4	1.0	2.5	21.5	0.035	0.055	<0.001	<0.01	0.005	0.004	0.24	

* Location is shown in Figure 1; < - Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 2766	Lincoln Park (well #1; old well sample taken at gate, kitchen tap)	30/12/75	<0.1															
"	"	07/01/76				7.5												
"	"	03/02/76	<0.1	<0.02		<2								0	52	20	72	N.D
"	"	06/04/76	<0.1	<0.02		15												
9	J. Butler	17/02/76	<0.1	<0.02		19.5												
10	B. Haefling	17/02/76	0.1	<0.02		3.8												

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; N.D. - Not detected; < - Refers to less than

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units; Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P _i		Iron (Fe)	Phenols
																Free ammonia	Total kjeldahl	Nitrite	Nitrate	Total	Soluble		
Well 3630	W. VanLaar	17/02/76	232	208		428	7.82	5	2.5	44	31.0	2.8	0.9	1.5	20.5	0.010	0.035	<0.001	<0.01	0.005	0.004	0.44	1
2766A	Lincoln Park (well #2, new well)	17/09/75	280	216			7.93	<5	2.7					23.5				0.029				0.21	
11	C. Liverance	17/02/76	312	268		570	7.59	<5	0.30	66	36.8	2.6	2.0	4.0	37.0	<0.005	0.055	<0.001	1.05	0.003	0.002	0.03	<1
12	I. Sims	17/02/76	268	240		484	7.68	<5	0.35	62	29.4	1.2	0.8	2.0	21.5	<0.005	0.055	<0.001	0.17	0.007	0.006	0.02	1

* location is shown in Figure 1, < - Refers to less than

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
Well 3630	W. Vanlaar	17/02/76	<0.1	<0.02		17												
2766A	Lincoln Park (well #2; new well)	17/09/75	0.1															
11	C. Liverance	17/02/76	<0.1	<0.02		3.8												
12	I. Sims	17/02/76	<0.1	<0.02		1.9												

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total Kjeldahl	Nitrite	Nitrate	Total	Soluble		
Y Springs	Inglis Falls spring	26/11/75	310	274		590	7.59					6.8	2.0	17	20	0.005	0.140	0.001	1.87	0.004	0.003	0.05	<1
Z	Sydenham Sportsmen Prop.	09/02/76	302	278			7.63	<5	0.70	67	35.8	3.6	1.6	7.0	27.0				1.97			0.01	
	Sydenham River																						
1	"	09/07/75	264	248		482	8.31					4.1	1.0	6.5	14.0	0.020	0.365	0.007	0.61	0.029	0.006	0.28	
2	"	09/07/75	262	251		518	8.20					4.1	1.0	7.0	14.5	0.035	0.230	0.007	0.60	0.040	0.015	0.32	
3	"	09/07/75	266	256		478	8.25					4.5	1.4	7.0	17.0	0.040	0.275	0.008	0.58	0.027	0.006	0.28	

* location is shown in Figure 1; < - Refers to less than.

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units;
Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons	Suspended solids
Springs Y	Inglis Falls spring	26/11/75				<2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01						
Z	Sydenham Sportsmen property	09/02/76				3.9													
	Sydenham River																		
1	"	09/07/75	<0.1		0.5	8													2.5
2	"	09/07/75	<0.1		1.5	12													9.5
3	"	09/07/75	<0.1		1.5	12													8.5

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; < - Refers to less than.

CHEMICAL ANALYSES OF WATER

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units; Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

[illegible]

* location is shown in Figure 1; < - Refers to less than

CHEMICAL ANALYSES OF WATER (CONT' D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons
well 6	R. Lunau		< 0.1	< 0.02		3.7												

* location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; < - Refers to less than

CHEMICAL ANALYSES OF LEACHATE

(Constituents in milligrams per litre, except Apparent colour in Hazen units, Turbidity in Formazin units;
Conductance in micromhos/cm at 25°C; Phenols in parts per billion; and pH)

Identification number*	Owner	Date	Hardness (CaCO ₃)	Alkalinity (CaCO ₃)	Bicarbonate alkalinity (CaCO ₃)	Conductance	pH at lab.	Apparent colour	Turbidity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Chloride (Cl)	Sulphate (SO ₄)	Nitrogen as N				Phosphorus as P		Iron (Fe)	Phenols
																Free ammonia	Total Kjeldahl	Nitrite	Nitrate	Total	Soluble		
Leachate spring	Owen Sound landfill - NE slope	19/07/75	1700	1230		10200	6.32					2250	180	2500	30	91	100	0.097		2.5	0.035	1500	
"	"	05/11/75				7800						970	167.5	900	+	73	101	0.300	<0.10	5.0	<0.05		
"	"	07/01/76	1720	188		7350	6.25					970	130	975		66.0	85.5	0.113	0.05	2.15	0.030	770	1750
"	"	18/02/76	1620	1740		7150	6.51	+	3250	480	140	960	128	1100	+	55.0	78.0	0.151	<0.01	10.0	0.043	600	1475
"	"	06/04/76	1460	2142		7000	6.50	3000	1180	400	136	930	120	1125	22.0	56.5	79.0	0.145	0.3	1.80	0.037	220	1025

* location is shown in Figure 1; + -Interference; < Refers to less than

CHEMICAL ANALYSES OF LEACHATE (CONT'D)

(Constituents in milligrams per litre, except Apparent colour in Hazen units; Turbidity in Formazin units; Conductance in micromhos/cm at 25° C; Phenols in parts per billion; and pH)

Identification number*	Owner or source	Date	Fluoride (F)	Sulphide (H ₂ S)	BOD	COD	Lead (Pb)	Zinc (Zn)	Copper (Cu)	Nickel (Ni)	Cadmium (Cd)	Manganese (Mn)	Chromium (Cr)	Tannins and lignins	IC	TOC	TC	Petroleum hydrocarbons	Suspended solids
Leachate spring	Owen Sound landfill NE slope	17/07/75			5100	19000													1169
"	"	05/11/75			6800	8620	0.20	6.7	<0.20	0.10	0.15	23	<0.40						3212
"	"	07/01/76			4500	7430													1102
"	"	18/02/76	0.2	+		7088								200	160	2280	2440	1	
"	"	06/04/76	0.2	<0.02		3701													

* Location is shown in Figure 1; BOD - Biochemical oxygen demand; COD - Chemical oxygen demand; IC - Inorganic carbon; TOC - Total organic carbon; TC - Total carbon; + - Interference; < - Refer to less than.

APPENDIX C
BACTERIOLOGICAL ANALYSES

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml)

Identification Number*	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Spring Y	Inglis Falls spring	11/06/75	0	640	0			
		26/11/75	0	0	0	0		
Well								
1	V. Wilson	26/11/75	6	4	22	0		
"	"	6/01/76	<4	8	8	<4	0	
2	R. Farrow	26/11/75	0	2	0	2		
3	W.G. Beckett	17/02/75	0	0	0	0		

* location is shown in Figure 1: < - Refers to less than

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml)

* Identification number	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Well 4	C. Byers	26/11/75	0	4	0	0		
5	J. Smith	17/02/76	0	44	2	0		
G98	I. Franklin	6/03/75	0	380	10			
"	"	12/03/75	0	0	0			
"	"	18/02/76					0	<30
4427	N. Barber	20/10/75	0	0	0	0		
"	"	26/11/76	0	0	0	0		
"	"	03/02/76	0	0	0	0		Absent

* location is shown in Figure 1; < - Refers to less than

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml)

Identification Number*	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Well 4427	N.Barber	18/02/76						230
7	R.Ledingham	26/11/75	0	96	0	0		
"	"	03/02/76	0	0	0	0		Present
"	"	18/02/76	0	0	0	0		4600
2981	D.Williton-E.Garnham	26/11/75	0	90	0	0	0	
"	"	06/01/76	<4	800	<4	<4	0	
"	"	03/02/76	0	0	0	4		Absent

* location is shown in Figure 1; < - Refers to less than

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml.)

Identification *number	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Well 2981	D.Williton-E. Garman	18/02/76						110
8	W.B. McKay	17/02/76	0	0	0	0		
697	L. Williton	26/11/76	0	0	0	0		
"	"	03/02/76	0	0	0	0		Present
"	"	18/02/76						<30

* location is shown in Figure 1; < - Refers to less than

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml)

Identification * number well	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
2766	Lincoln Park (well #1, old well)	12/04/75	0	0	0	<4		
"	"	17/09/75	0	0	0	0		
"	"	26/11/75	0	70	0	18		
"	"	03/02/76	0	0	0	0		Absent
"	"	18/02/76						<30
9	J. Butler	17/02/76	0	4	0	0		

* location is shown in Figure 1; <- Refers to less than

BACTERIOLOGICAL ANALYSES OF WATER
(Results per 100 ml)

Identification *number	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Well 3630	W. Vanlaar	17/02/76	0	0	0	0		
10	B. Hoefling	17/02/76	0	0	0	0		
2766A	Lincoln Park Well #2 new	17/09/75	0	0	0	0		
11	C. Liverance	17/02/76	0	0	2	0		

* location is shown in Figure 1.

BACTERIOLOGICAL ANALYSES OF WATER

(Results per 100 ml)

* Identification number	Owner	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
well 12	I. Sims	17/02/76	0	0	0	0		
4941	E. Cameron	20/10/75	0	0	0	0		
"	"	26/11/75	0	0	0	0		
"	"	03/02/76	0	0	0	4		Absent
"	"	18/02/76						30

* location is shown in Figure 1.

BACTERIOLOGICAL ANALYSES OF LEACHATE

(Results per 100 ml)

Identification *	Owner - location	Date	Fecal coliform	Background colonies	Coliform bacteria	Enterococcus	Pseudomonas aeruginosa	Sulphate reducers
Leachate spring	Owen Sound sanitary landfill - NE slope	18/02/75						$\geq 24,000$

* location is shown in Figure 1; \geq - Refer to greater than or equal to.

SEP 7 1976

NOV 12 1976

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Southwestern Region. Technical.....

Impact of Owen Sound sanitary
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SEP 3 1976	N.A. CHOWDHRY - APPSCL
SEP 3 1976	J. HAWKARD - W.A.
SEP 20 1976	T. ELMORE - 135-0

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